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Corrugated fibreboard — Determination of edgewise crush resistance (unwaxed edge method)

Carton ondulé — Détermination de la résistance à la compression sur chant (méthode sans enduction de cire)

Reference number
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Foreword

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The committee responsible for this document is ISO/TC 6, *Paper, board and pulps*, Subcommittee SC 2, *Test methods and quality specifications for paper and board*.

This fifth edition cancels and replaces the fourth edition (ISO 3037:2007), which has been technically revised. Specifications for the compression testing machine have been replaced by reference to ISO 13820. Details of acceptable cutting devices have been moved to an informative annex and have been replaced by specifications of the quality of cut. In addition, precision data have been inserted in Annex B.

Introduction

A variety of methods for the determination of edgewise crush resistance are in use in different parts of the world. These can be classified into three groups as follows:

a) Those in which a carefully cut rectangular test piece is tested without any special treatment or modification (e.g. ISO 3037).

b) Those in which the edges of the test piece to which the force is applied are waxed, to prevent the test result being influenced by "edge effects" (e.g. ISO 13821, *Corrugated fibreboard — Determination of edgewise crush resistance — Waxed edge method*).

c) Those in which the test piece edges are not waxed but the shape of the test piece is such that the length is substantially reduced at a point midway between the loaded edges, in order to induce the failure to occur away from those edges (e.g. JIS Z 0403-2).

The dimensions of the test piece vary from one group to the other and, in group c), the methods vary in the shape and method of reducing the length, and in whether or not the test piece is held in a clamp during crushing.

The methods may not give the same numerical results, but it can be shown that most of them can be used to predict the top-to-bottom compression strength which will be achieved when the board is properly converted into a transport package.

This International Standard describes a method from group a). It is intended as a method for quality measurement and quality specification purposes and is selected because it correlates with the top-to-bottom compression strength of the final transport package and because it is the simplest and most operationally convenient method, an important factor when large numbers of tests need to be conducted. However, it does not measure the actual intrinsic compressive strength of the corrugated fibreboard, giving lower results than most of the methods in groups b) and c). This systematic difference is due to edge effects.

Other methods may be used for other purposes, particularly when the object of the test is to study fundamental structural characteristics of the package.

There are methods available for calculating the edgewise crush resistance from the compression strength of the component papers.

Corrugated fibreboard — Determination of edgewise crush resistance (unwaxed edge method)

1 Scope

This International Standard specifies an unwaxed edge method for the determination of the edgewise crush resistance of corrugated fibreboard. It is applicable to all corrugated fibreboard grades.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 186, *Paper and board — Sampling to determine average quality*

ISO 187, *Paper, board and pulps — Standard atmosphere for conditioning and testing and procedure for monitoring the atmosphere and conditioning of samples*

ISO 13820, *Paper, board and corrugated fibreboard — Description and calibration of compression-testing equipment*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
edgewise crush resistance
maximum force per unit length that a test piece of corrugated fibreboard can support until the onset of failure when a compressive force is applied with the flute structure perpendicular to the loading surfaces

4 Principle

A rectangular test piece of corrugated fibreboard, placed between the platens of a compression tester with the flutes perpendicular to the surfaces of the platens, is subjected to an increasing compressive force until failure occurs. The maximum force sustained by the test piece is measured.

5 Apparatus

5.1 Fixed-platen compression testing machine as described in ISO 13820. It is preferable to avoid the use of emery paper on the platens.

While it is safer to avoid the use of emery paper on the platens, because it is a requirement of other test methods, the platens may be faced with very fine emery paper of a grade not coarser than 00. Where this is done, due regard should be paid to maintaining the flatness and parallelism requirements specified for the faces.

NOTE A flexible beam compression tester per ISO 13820 is not recommended for this test method as there are significant questions regarding its ability to be maintained with sufficient parallelism to provide accurate test values for these specimens.

5.2 Cutting device, such as a high-speed table saw or Billerud-type cutter (see Annex A), capable of cutting test pieces to the quality of cut described in 8.3 and 8.4.

5.3 Guide blocks, two rectangular, smooth-finished, blocks of dimensions approximately 20 mm x 20 mm x 100 mm, to support the test piece and keep it perpendicular to the platen surfaces. It is advisable to fit each guide block with a probe, to enable each block to be moved safely during the test.

6 Sampling

If the average quality of a lot of corrugated fibreboard is to be determined, sampling shall be carried out in accordance with ISO 186. If another type of sample is to be tested, make sure that the test pieces taken are representative of the sample received.

7 Conditioning

The sample shall be conditioned in accordance with ISO 187.

8 Preparation of test pieces

8.1 Prepare the test pieces in the same atmospheric conditions as used to condition the sample.

8.2 Using a sharp blade and a procedure that ensures the cuts are parallel, cut, from the sample, specimens with the following dimensions: 100,0 mm ± 0,5 mm in the direction perpendicular to the flutes and 70 mm to 300 mm in the direction parallel to the flutes, such that test pieces can be obtained from an undamaged area of the sample.

8.3 From undamaged areas of the specimens (8.2), using an appropriate cutting device (5.2), cut sufficient test pieces 25,0 mm ± 0,5 mm in the direction parallel to the flutes, so that 10 valid tests are obtained. Each test piece will then measure 25,0 mm ± 0,5 mm in height (the direction of the flutes) and 100,0 mm ± 0,5 mm in length (the direction perpendicular to the flutes).

If a Billerud-type cutter (5.2) is used, insert the uncut strip until it almost contacts the end stop, and ensure that a sufficient length of strip extends on the other side of the blades and that the edge is in contact with the squareness guide.

Irrespective of the method of cutting, the edges subjected to load shall be cleanly cut, straight, parallel and perpendicular to the board surfaces (8.4).

8.4 Test piece quality. Each test piece shall be examined for quality.

The width of the test piece shall not vary by more than 0,1 mm along its length.

Cleanness of cut is judged by inspection of the test pieces. Flutes shall show no discernible distortion, and the cut edges shall not be furry or have loose fibres visible when inspected under normal laboratory conditions, i.e. under room lighting with no magnification.

Straightness, parallelism and perpendicularity may be judged by the following procedure.

Stand two test pieces on their cut edges on a plane surface with two of their faces almost touching. With perfectly flat board, the two adjacent faces should appear flat and parallel to each other over their whole surface. If the board is warped, this may not be so, but the test pieces are acceptable if they stand vertically on their bottom edges, if the top cut surfaces appear flat and parallel to each other and at right angles to the liner surfaces close to the cut, and if the cut ends of the test pieces appear to be in the same plane. It should not be possible to see light under the cut edge of either test piece, when a load of about 1 N (equivalent to light finger pressure) is applied to the top edge.

Rotate one test piece end-for-end (rotate 180° about its vertical axis) and invert it (rotate 180° about its horizontal axis), then invert the other test piece. In each configuration, the criteria of the preceding paragraph shall apply.

Test other pairs of test pieces in the same way.

With cutters of the high-speed saw and Billerud type (Annex A) and any other type of cutter, where relevant, these checks should be done when the cutter is first used to establish that it is operating correctly. Thereafter, the checks should be done periodically to ensure that the cutter remains in good condition.

NOTE The quality of test piece cutting can have a significant effect on the test results and it is therefore essential that this be maintained to the highest possible standard. More information on the importance of accurate, parallel cutting can be found in the References in the bibliography.

9 Procedure

Conduct the tests in the standard atmosphere that was used in Clause 7.

With the platens of the compression tester (5.1) conveniently separated, place the test piece on one of its 100 mm cut edges onto the lower platen. Support it by placing a guide block (5.3) on each side. The guide blocks may be relocated away from the test piece when the load reaches about 50 N. They may be either left on the platen or removed from it. If applicable, take whatever action is appropriate to ensure that the weight of the guide blocks does not contribute to the force reading.

Operate the tester until the test piece fails. Test failure can be identified by a maximum in the load-deflection curve, which often corresponds to visual compression in the body of the specimen and/or curling of the edges of the specimen where they are in contact with the loading platens.

Record, to the nearest 1 N, the maximum force, F_{max}, developed up to the moment when instant failure occurs. Repeat the test on sufficient test pieces, so that at least 10 valid results are obtained.

10 Calculation

10.1 Calculate the mean maximum force, $\bar{F}_{max}$, and standard deviation, $s_{F_{max}}$.

10.2 Calculate the edgewise crush resistance R, expressed in kilonewtons per metre, to the nearest 0,01 kN/m using the equation:

$$R = \frac{\bar{F}_{max}}{l} \quad (1)$$

where

$\bar{F}_{max}$ is the mean maximum force, in newtons;

l is the length of the test piece, in millimetres (100 mm).

10.3 Calculate the standard deviation of the edgewise crush resistance, s_R, expressed in kilonewtons per metre, to the nearest 0,01 kN/m, using the equation: